Project ID # VAN016

Transportation Data Program

A Multi-Lab Coordinated Project

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June 5-9, 2017

This presentation does not contain any proprietary, confidential, or otherwise restricted information

Overview

Timeline

- Project start date: October 2015
- Project end date: September 2018
- Percent complete: 50%

Barriers

- Barriers addressed
  - *Multi-Year Program Plan 2011 - 2015*

    Section 2.6 Outreach, Deployment and Analysis A, B, C

    Section 3.2 Program Analysis

Budget

- Total project funding
  - $750K / year

Partners

- Oak Ridge National Laboratory (ORNL)
- National Renewal Energy Laboratory (NREL)
- Argonne National Laboratory (ANL)

Overview

Since 1975

OAK RIDGE National Laboratory

- Transportation Energy Data Book (TEDB)
- Vehicle Technologies Market Report (Market Report), and
- Vehicle Technologies Fact of the Week (FOTW)

Since mid-1990's

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

- Vehicle Technology Consumer Data
  - Consumer Views on Plug-In Electric Vehicles–National Benchmark Report

Since 1999

Argonne NATIONAL LABORATORY

- Electric-drive (E-Drive) Vehicle Sales Data and Market Analysis
  - E-drive sales
  - Regional sales patterns
  - Vehicle ownership cost

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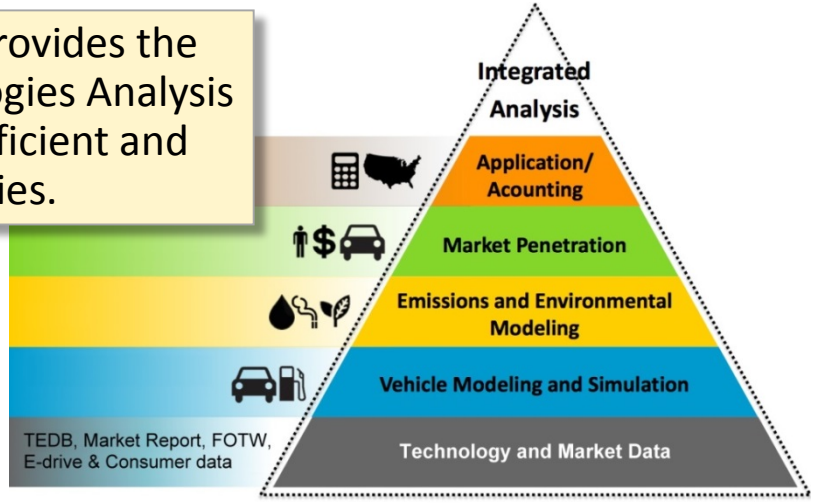
Relevance

The Transportation Data Program provides the foundation for the Vehicle Technologies Analysis Program in the pursuit of energy-efficient and environmentally-friendly technologies.



Data Collected in the Transportation Data Program provides input data to other VTO programs and other Agency's models, such as:

- MA3T
- GREET
- ADOPT
- Parachoice
- GPRA analysis
- DOE eGallon Initiative
- DOE Advanced Technology Manufacturing Loans Program
- National Science Foundation website
- EIA MOVES
- EPA NEMS

Policymakers, transportation analysts, and VTO staff require quality current and historical data and information on the transportation sector to affect good decisions for the future.

The Mission of the Vehicle Technologies Office (VTO) is to develop and assist in the deployment of more energy-efficient and environmentally friendly technologies for highway transportation passenger and commercial vehicles that will meet or exceed performance expectations and environmental requirements, enabling the U.S. to use significantly less petroleum and reduce greenhouse gas emissions. - *Multi-Year Program Plan 2011 – 2015*

Milestones

Quarter	Milestone Description	Milestones for each individual projects FY16	Milestones for the Transportation Data Program FY17
Quarter 1	Fact of the Week prepared weekly for posting on the Vehicle Technologies website	Complete	Complete
Quarter 2	U.S. E-drive Monthly Sales Report prepared monthly for posting on the E-drive website	Complete	Complete
Quarter 3	Draft of Vehicle Technologies Market Report delivered to VTO	Complete	Complete
Quarter 4	Draft of Transportation Energy Data Book delivered to VTO	Complete	On track
Quarter 4	Draft of Consumer Views/Benchmark Report delivered to VTO	Complete	On track
Quarter 4	Go/no-go milestone Determine if VTO research efforts require continued transportation data program support	Complete	On track

Approach - TEDB, Market Report & Weekly Fact

Barrier Addressed: Provides a wealth of information used as a DOE outreach to improve analyses of the transportation sector which contribute to policies, programs, and technologies

- The Data Book is mostly tabular historical data, especially good for modeling use.
- The Market Report includes market-related data & some company-specific data for the top U.S. manufacturers.
- The Fact of the Week is widely varied on topic and source.

Discovery

- Content review of past reports/Facts
- Source identification
- Data collection from hundreds of sources
  - From html, Excel, pdf & hardcopy

Due Diligence

- Convert units
- Perform calculations
- Confirm all series revisions
- Analyze disparate data
- Study definitions
- Assemble notes
- Create graphics and tabulations
- Write accompanying text

DOE Approval

- Send to VTO sponsor for approval
- Topic and text of Fact reviewed by VTO sponsor, VTO Director & VTO Communications Team members
- Contents of TEDB & Mkt Report reviewed by VTO sponsor
- Changes made by ORNL accordingly

Outreach

- Send final Fact & Excel file to VTO website programmer
- Program final Fact in GovDelivery system & send email to subscription list
- Update TEDB & Mkt Report Websites (Serve data in Excel & pdf)
- Answer questions from the public
- Request user feedback

Approach - Consumer Data

Barrier Addressed: Provides DOE VTO with a capability to track and investigate high-level consumer sentiments affecting VTO technology deployment

- Provides the voice of the consumer to contextualize research
- Stated and revealed preference differences limit application in modeling.

Sample of Topic Areas	Time Series	Deep-Dives
PEV awareness and exposure	●	
BEV range	◒	FY15
Willingness to pay for fuel economy and PEV	◒	FY15
Alternative fuel preferences	●	
Fuel economy perceptions	◒	FY15
Connected and automated vehicles		FY17

● - Tracked annually across multiple questions

◒ - Tracked annually at high level

- Study structure and content is influenced by input from VTO Analysis Team experts and a broad working group representing partner agencies, DOE national laboratories, academia, and private researchers.
- Study results support VTO Analysis team efforts including the TEDB, VT Market Report, ORNL BEV range research, and the VT Quarterly Analysis Review amongst others.

Primary mechanism: Subcontract with ORC International for Caravan omnibus telephone survey of 1,000 adults designed to reflect the general U.S. population.

ORC is a broadly recognized firm and founding partner of the Council of American Survey Research Organizations dedicated to promoting standards in survey research.

PEV = Plug-In electric vehicle; BEV = Battery electric vehicle.

Approach - E-Drive Data & Market Analysis

Barrier Addressed: Provides readily used sales and ownership cost data, analyzes regional sales patterns to improve market modeling of the electric-drive vehicle ecosystem, and supports other DOE programs

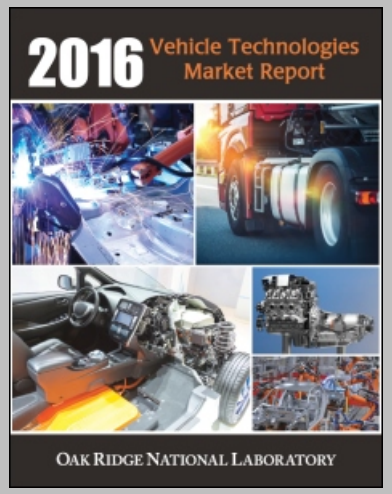
- Provides reference data for vehicle choice modeling and DOE/EERE policy impact analysis.
- Examines geographic distribution and demographics to characterize market.
- Creates more comprehensive levelized costs for advanced vehicle technologies.

Topic	Data and Analysis Types (Examples)
U.S. E-drive sales	Monthly sales of HEV, PHEV and BEV
International sales	Monthly sales of HEV, PHEV and BEV in China, Europe, Japan
Policy and infrastructure	Incentives, regulations, targets, number of charging stations (by type)
Regional sales pattern	Contributing factors to PEV adoption Comparison between major MSAs
Vehicle ownership cost	Residual values of Volt, LEAF, Prius, Ford Energies, etc.

Primary mechanism: E-drive vehicle sales by make and model of four global markets (Canada, China, Europe, Japan and U.S) and ownership cost information of key PEV and HEV models.

Technical Accomplishments and Progress for Data Book, Market Report, and Fact of the Week

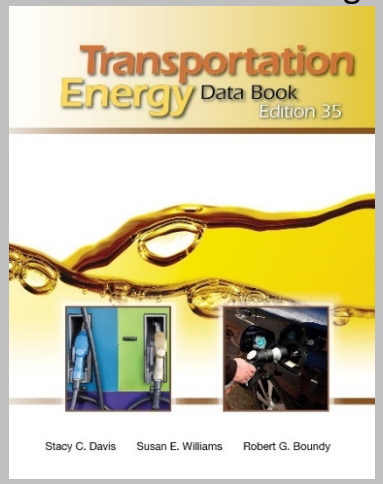
Successful Outreach: Facts & Market Report published, Data Book coming



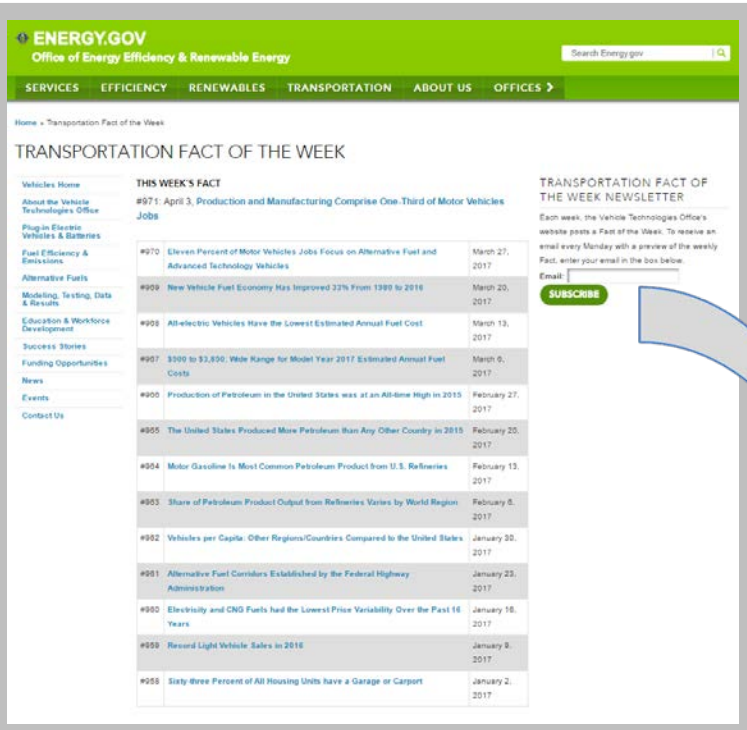
http://cta.ornl.gov/vtmarketreport

http://cta.ornl.gov/data

Edition 36 forthcoming



Average Monthly Website Visitor Sessions		
	Market Report	Data Book
FY15	3,524	6,502
FY16	4,403	9,089
FY17*	4,757	9,386
Google Scholar Citations		
April 2017	80	2,750



http://energy.gov/eere/vehicles/transportation-fact-week

> 4,800 subscribers to the Fact of the Week Monday email distribution

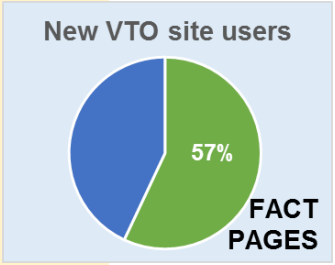
* October through March

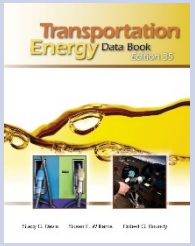
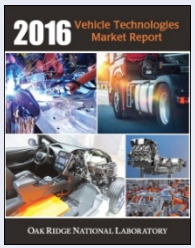
Technical Accomplishments and Progress for Data Book, Market Report, and Fact of the Week

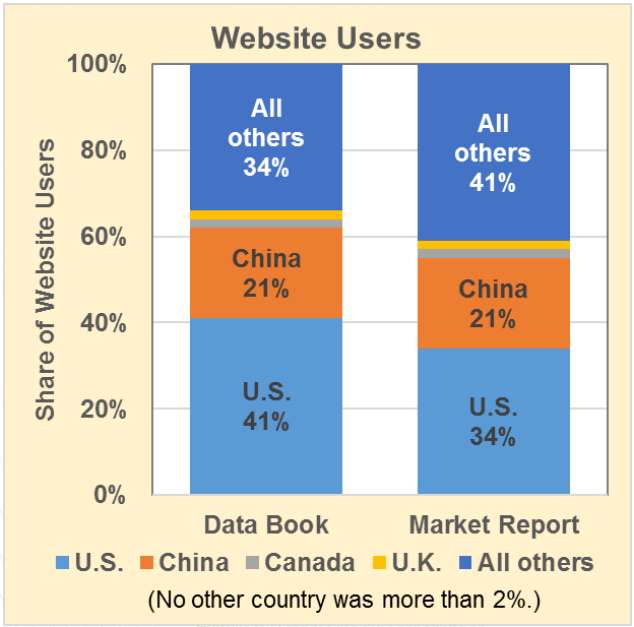
Successful Outreach: Website Statistics for FY17 (Oct through March)

- The Fact of the Week accounted for 33% of all VTO website pageviews
- About 57% of new VTO site users came into the site through the Fact of the Week
- The most visited VTO website pages:

  Fact 915, Average Historical Annual Gasoline Pump Price from 1929-2015
  Fact 861, Idle Fuel Consumption of Selected Gasoline and Diesel Vehicles



Most Downloaded Excel Tables	
	Table 10.10 Average Price of a New Car
	Table 4.29 Driving Cycle Attributes
	Table 4.8 Production, Production Shares, and Production-Weighted Fuel Economies of New Domestic and Import Cars
	Table 2.15 Energy Intensities of Highway Passenger Modes
	Table 2.8 Transportation Energy Use by Mode
	Table 23 List of Top Ten Tier 1 Global Suppliers
	Table 34 Batteries for Selected Hybrid Electric Vehicles
	Figure 94 Class 8 Truck Sales by Manufacturer
	Table 35 Hybrid and Electric Cargo Trucks on the Market
	Figure 96 Diesel Engine Manufacturers Market Share



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Technical Accomplishments for Consumer Data

Consumer Views on Plug-in Electric Vehicles National Benchmark Study

- The annual study tracks PEV awareness, acceptance, and perceived barriers to broader acceptance.
- Published second annual study: http://www.nrel.gov/docs/fy17osti/67107.pdf.
- Third annual study completed in February 2017 with publication to follow.

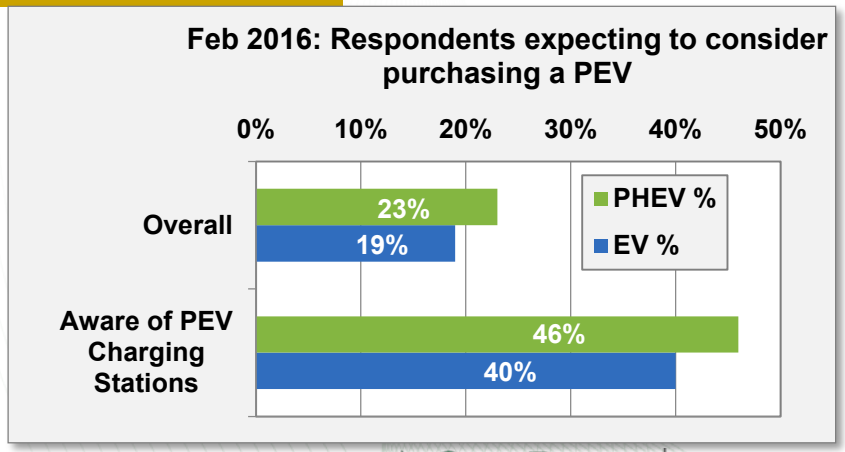
		Feb 2015	Feb 2016	Feb 2017
PEV Awareness	Able to name a specific PEV	48%	46%	46%
	Aware of PEV tax incentives	NA	33%	23%
Barriers to PEV Acceptance	Able to plug in at home	53%	49%	54%
	300 miles sufficient BEV range	56%	46%	47%
	Unaware of PEV charging stations	79%	76%	70%
	Willing to pay extra for a PEV	51%	49%	47%
PEV Acceptance	Expect to consider a PEV (Expect to buy)	20-24% (2%)	19-23% (3-4%)	21-24% (2-3%)

Initial trends show little movement in PEV sentiments. As the market matures, the annual study will allow for identification of changing perceptions.

In an early adoption market it is helpful to identify where further investigation is warranted.

Example: Awareness of existing charging stations appears to correlate with higher acceptance.

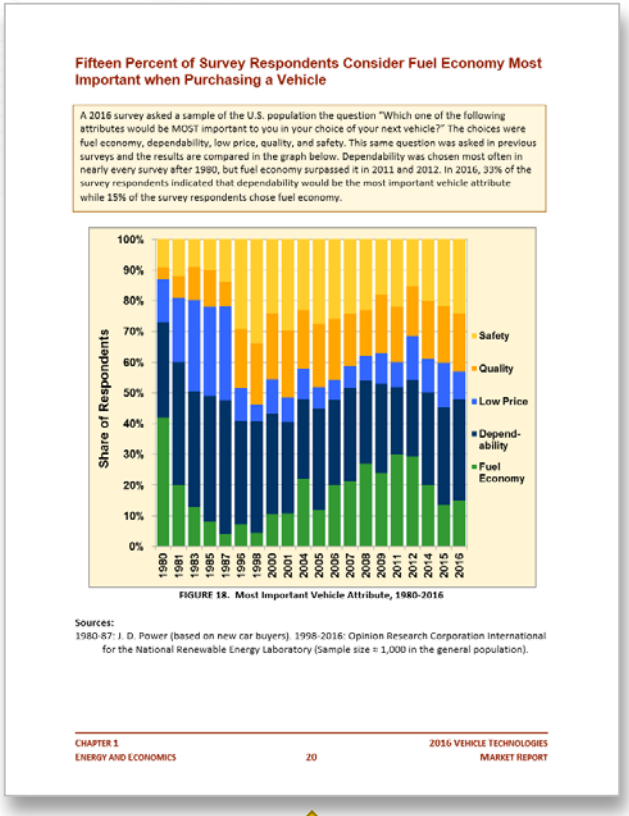
→ Why? Is additional infrastructure necessary?



Data notes:
Sample weight adjusted to reflect general U.S population; Sample Size: ~1,000 respondents
Margin of error of ±3% at the 95% confidence level

Technical Accomplishments for Consumer Data

Consumer Data feeds into other VTO Analysis Program work



Fifteen Percent of Survey Respondents Consider Fuel Economy Most Important when Purchasing a Vehicle

A 2016 survey asked a sample of the U.S. population the question "Which one of the following attributes would be MOST important to you in your choice of your next vehicle?" The choices were fuel economy, dependability, low price, quality, and safety. This same question was asked in previous surveys and the results are compared in the graph below. Dependability was chosen most often in nearly every survey after 1980, but fuel economy surpassed it in 2011 and 2012. In 2016, 33% of the survey respondents indicated that dependability would be the most important vehicle attribute while 15% of the survey respondents chose fuel economy.

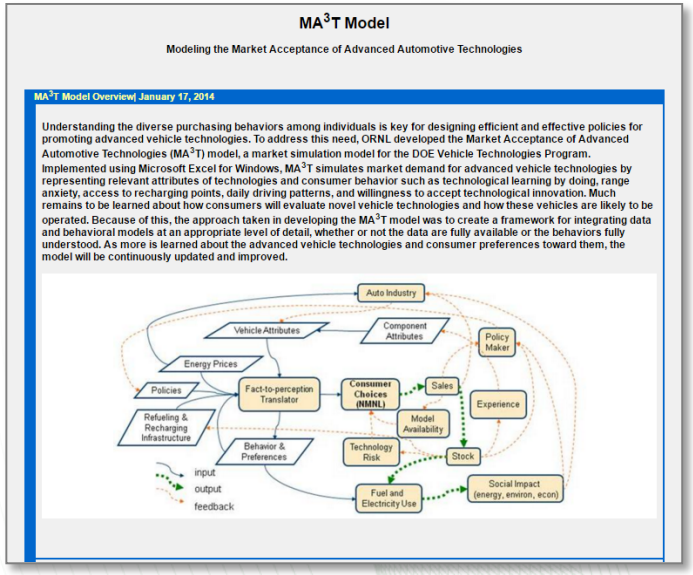
FIGURE 18. Most Important Vehicle Attribute, 1980-2016

Sources:
1980-87: J. D. Power (based on new car buyers). 1998-2016: Opinion Research Corporation International for the National Renewable Energy Laboratory (Sample size = 1,000 in the general population).

CHAPTER 1 ENERGY AND ECONOMICS 20 2016 VEHICLE TECHNOLOGIES MARKET REPORT

2016 Vehicle Technologies Market Report, and future Facts of the Week

The consumer data will be used to inform VTO consumer choice models, such as the MA^{3}T Model, on the value of plug-in vehicle range and vehicle fuel economy.



MA^{3}T Model

Modeling the Market Acceptance of Advanced Automotive Technologies

MA^{3}T Model Overview| January 17, 2014

Understanding the diverse purchasing behaviors among individuals is key for designing efficient and effective policies for promoting advanced vehicle technologies. To address this need, ORNL developed the Market Acceptance of Advanced Automotive Technologies (MA^{3}T) model, a market simulation model for the DOE Vehicle Technologies Program. Implemented using Microsoft Excel for Windows, MA^{3}T simulates market demand for advanced vehicle technologies by representing relevant attributes of technologies and consumer behavior such as technological learning by doing, range anxiety, access to recharging points, daily driving patterns, and willingness to accept technological innovation. Much remains to be learned about how consumers will evaluate novel vehicle technologies and how these vehicles are likely to be operated. Because of this, the approach taken in developing the MA^{3}T model was to create a framework for integrating data and behavioral models at an appropriate level of detail, whether or not the data are fully available or the behaviors fully understood. As more is learned about the advanced vehicle technologies and consumer preferences toward them, the model will be continuously updated and improved.

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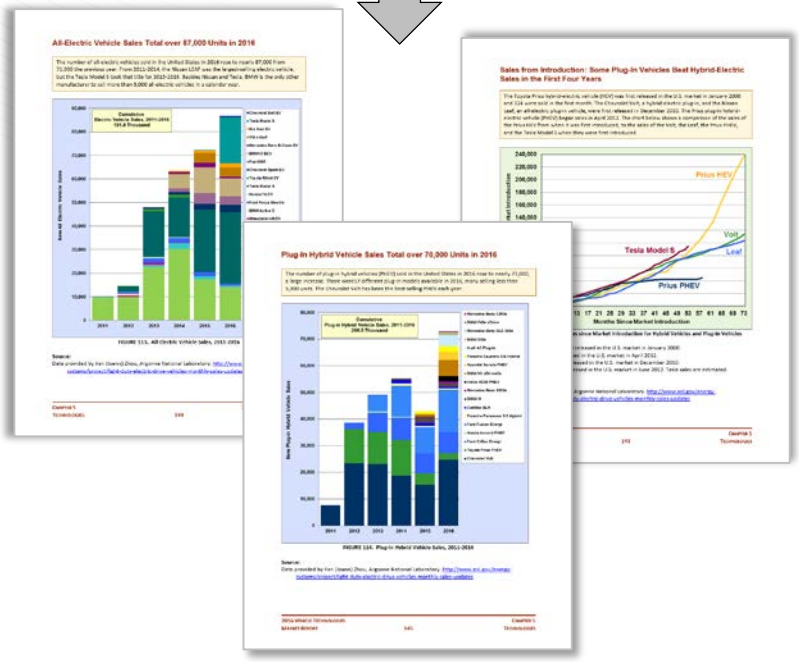
Technical Accomplishments for E-Drive Data

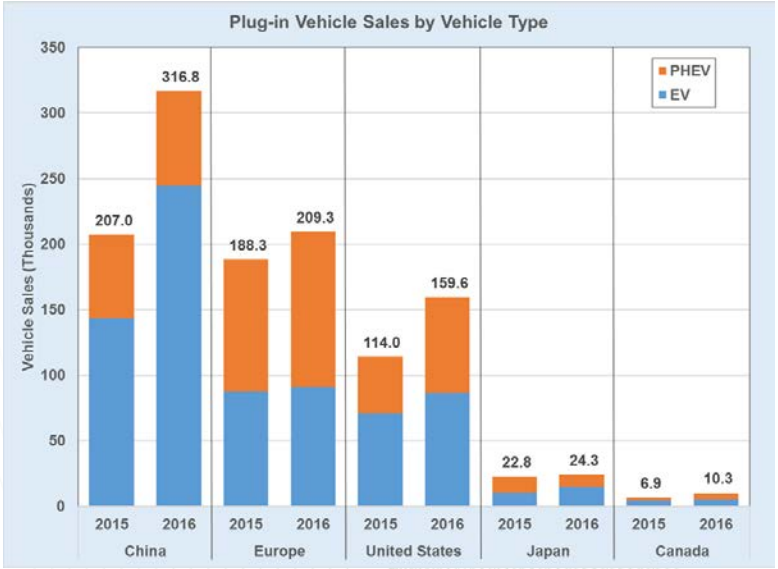
Extensive use of data products by DOE programs and other agencies

2016 Vehicle Technologies Market Report



Fact #976: China has the Highest Number of Sales of Plug-in Vehicles in the World

- Successfully published sales and market trends on website monthly http://www.anl.gov/energy-systems/project/light-duty-electric-drive-vehicles-monthly-sales-updates
- Supported DOE/EERE programs and activities such as eGallon, Workplace Charging, Market Report, and Fact of the Week



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Technical Accomplishments for E-Drive Data

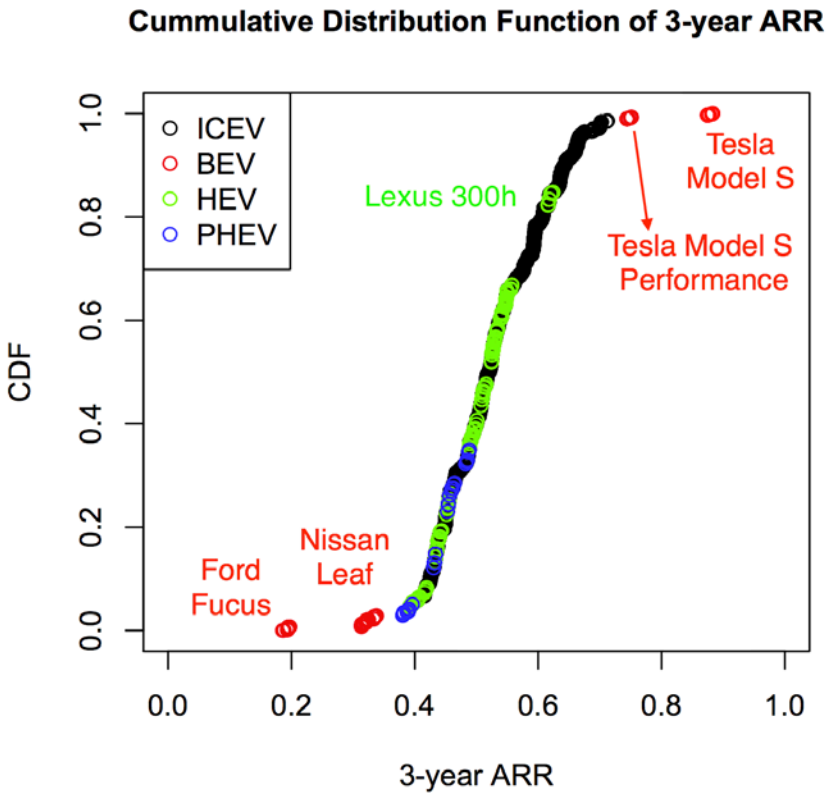
Varying sets of variables to be significantly correlated with each PEV market segment (mass, medium, luxury) at county level.

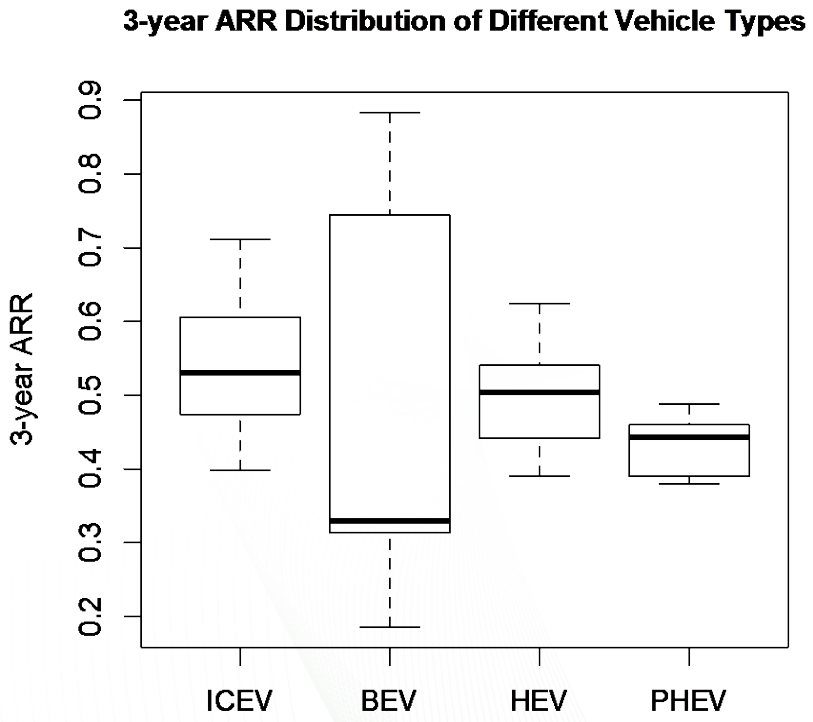
- Negative effects of **extreme temperature** were particularly strong for the total market and for the mass-market BEVs
- **State and federal monetized benefits** were twice as important for BEVs as for PHEVs
- **Level 2 public charging** availability shows significant positive impacts in the mass and total PHEV markets, but not in BEV markets.
- **Workplace charging** shows a positive but lower coefficient for BEVs than for PHEVs
- **PEV Readiness Grants** had consistent positive and generally significant impacts in all PHEV market segments, as well as mass-market and total BEVs
- **HOV lane subsidies** appear to be very important in the mass market
- **Income** has significantly positive impacts in EVERY market segment, dominating the education effect.
- **Fuel Cost:** Interestingly, gasoline prices are negatively correlated to the luxury BEVs, luxury PHEVs and mid-market PHEVs, but not mass-markets or total markets.
- Longer **Work Travel Time** significantly decreases luxury BEV and mid-market PHEV market adoption, but not mass markets.

Source: Contributing factors in plug-in electric vehicle adoption in the United States: A Metro/County level approach, submitted to 2017 Annual TRB Meeting on Aug. 1, 2016.

Technical Accomplishments for E-Drive Data

BEV have a wide range of 3-year value retention rates. Tesla models outperform others.





$$\text{Adjusted Retention Rate}_i = \frac{\text{New Car Price} - \text{Depreciation Value Till Year } i}{\text{New Car Price} - \text{Tax Credits}}$$

Note: 1. Depreciation values downloaded from Edmunds.com in December 2016
2. New car price is the price in the year when the vehicle was new

Previous ORNL Reviewers' Comments

Comment	Response
Track the information most accessed on the websites to focus and prioritize areas that merit expansion or less frequent updates	Information is available on website users and downloads from our TEDB and Market Report websites which are hosted at ORNL and statistics from those sites are now in this presentation. Many TEDB and Market Report users download the full report as a single pdf file or a zipped file containing all Excel sheets and use the information from their own computers, thus we cannot track the specific data they are using. On the Fact of the Week, those with access to the VTO website can provide usage statistics. We have used those to repeat/update popular Facts more often (e.g., the historical price of gasoline is the most popular Fact ever).
Update the data more often than annually to make them available for use faster	Some data are only available on an annual basis, but may come out on a different schedule than our products (e.g., data available every Spring is not published in the TEDB until the Fall). Our current budget allows for an annual update of the TEDB and Market Report. With additional funding, plans could be made for additional updates on-line at different times of the year. Currently, because the TEDB and Market Report include the source of each data tabulation/graphic, one can use that information to find the original data source for updated information. In some cases, however, the information would not be free of charge.
It is not clear how the data and information from this project are used by the other projects	The data and information generated from this project are used inside and outside of the program in many different ways: • Modelers (MA3T, GREET, ADOPT, VISION, GPRA, NEAT, EPA's MOVES, EIA's NEMS…) need input data upon which to base their model and use various data from throughout the Transportation Data Program (e.g., vehicle miles, fuel economy, EV sales, consumer preference data) to meet those needs. • Researchers use the data in research papers and on presentation slides to illustrate information about the transportation sector. Examples of other uses for the data include: • VTO staff use the data to answer questions from the public. • Startup companies/inventors use the data for analyzing the market for their technologies. • Librarians use the data to answer questions from their users. • Students use data for dissertations, theses, college and high school papers.

Previous NREL and ANL Reviewers' Comments

Comment	Response
NREL NATIONAL RENEWABLE ENERGY LABORATORY	
The effort relies too heavily on stated preference data	Revealed preference data is preferential whenever available, and the Consumer Data task seeks out opportunities to contextualize study results with robust data sets such as IHS/Polk vehicle registration and U.S. Census data. Broadly, the effort provides a voice of the consumer when technologies are not yet available or new to a marketplace and actual behaviors cannot be tracked. While study results can be interpreted to reveal a lack of consumer understanding about study topics, this lack of understanding is in itself a useful finding.
Add state or region-specific questions in early adoption markets or increase nationwide survey sample size	The task is investigating possible regional breakdowns where the current data collection allows for reasonable sample sizes. State or regional target markets and/or an increased nationwide sample size could be performed with additional funding.
Early adopter PEV usage data from Idaho National Lab could inform future questions on consumer surveys	The Consumer Data task has benefitted from INL PEV usage data and expertise from Jim Francfort. The task will seek out collaboration with John Smart as new studies are developed.
Argonne NATIONAL LABORATORY	
Make the international PEV sales publically available	PEV sales by make and model in Japan and China can not be shared with public due to the agreement with the data provider, Tsinghua University, Beijing, China. PEV sales in Europe are publically available on the European alternative fuels observatory website.
BEVs have been very successful in Scandinavia and questioned why they could not also be successful in the northern United States	ANL analyzed the PEV share in both cold and warm states which does not have financial PEV incentives/credits and found a statistic difference between this two groups in terms of BEV share of PEV and PHEV share of PEV. BEVs have been very successful in Scandinavia, which comes with a very expensive price tag. Norway government has implemented several financial and non-financial incentives to stimulate PEV adoption.

Collaboration and Coordination with Other Institutions

Government Agencies	Private Sector	National Laboratories	Academia
• DOE Clean Cities Program • Dept. of Transportation • Environmental Protection Agency • Energy Information Administration • Census Bureau • California Air Resources Board • Bureau of Economic Analysis • Bureau of Labor Statistics	• CSRA • Opinion Research Corporation • IHS Automotive/Polk • Ward's Automotive • Crain Communications • Navigant Research • European Alternative Fuels Observatory, Brussels • Automotive Industry Newsletter, London, England • International Energy Agency • American Public Transportation Association	• ANL • NREL • ORNL • Lawrence Berkeley National Laboratory • Pacific Northwest National Laboratory • Sandia National Laboratory	• University of California –Davis • University of Michigan • Tsinghua University, Beijing, China

ORNL, NREL, and ANL work with these and other institutions on the transportation data that are produced by this project.

Remaining Challenges and Barriers

- The challenge in this world of instantaneous information is to have reliable up-to-date data for the VTO Analysis Team, transportation modelers, policymakers, and others who rely on the Transportation Data Program to inform their analyses.

- The Fact of the Week and the monthly U.S. E-drive sales data are two parts of the Transportation Data Program that have frequent data releases.
  - With additional funding, more frequent updates to the Market Report and Transportation Energy Data Book websites could be performed, based on the availability and timing/frequency of the source materials.
  - As the market for advanced vehicle technologies rapidly evolves, consumer preference studies could be conducted more frequently and at a more detailed level to better understand these changes if additional funding were available.

Proposed Future Work

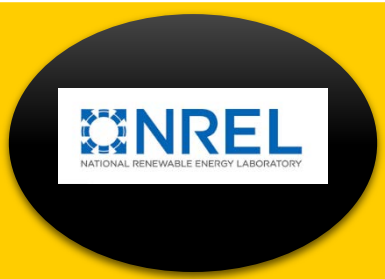
All future work will be updated to the latest possible data/information available and will include new material on emerging topics of interest

Remainder of FY17

- Fact of the Week
- Transportation Energy Data Book

FY18

With additional sources and continually evolving displays of data, the Weekly Fact, Market Report and Data Book will provide easy access to critical data that form the foundation for transportation analysis worldwide.



Remainder of FY17

- PEV Benchmark study
- Connected and Automated Vehicles Study

FY18

The effort will continue to refine question sets based on working group feedback and investigate new areas of research interest as the market for VT technologies evolves

- Benchmark study
- Deep-dive investigations of hot topics
- Look for opportunities to expand collaboration efforts

Remainder of FY17

- Monthly National E-drive sales
- Quarterly Regional PEV sales
- Quarterly Global PEV sales

FY18

In light of the evolving EV market:

- Keep track of monthly PEV sales
- Investigate new contributing factors in regional sales
- Analyze ownership data of more PEV and HEV models

Answer ad hoc data requests from VTO staff and Analysis Program team members

Any proposed future work is subject to change based on funding levels

Summary

Successful weekly, monthly, and annual milestones delivered on-time and within budget – improving over time

Transportation Analysis and Deployment

VTO Models (GREET, MA3T, GPRA, VISION, etc.)

DOE Outreach (e.g., EPA MOVES, EIA NEMS, etc.)

New policies, programs and technologies addressing transportation efficiency

Reduce petroleum use and greenhouse gas emissions

Collaboration with government, private sector, academia, & other laboratories

ACKNOWLEDGEMENTS

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US Department of Energy

Philip Patterson, retired
Formerly of the Office of Vehicle Technologies
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